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OPTICAL TRANSMISSION METHOD WITH PM/AM CONVERSION

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(57) Claim

1. Method for optical signal transmission with a range limited by the group velocity dispersion of the glass fibre used for the transmission, characterized in that, on the transmission side, a phase-modulated optical signal is generated with the information to be transmitted, which signal is emitted to a glass-fibre transmission path and experiences an amplitude modulation along this transmission path because of its group velocity dispersion, and in that, on the reception side, the transmission signal is detected with respect to its amplitude modulation.

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AUSTRALIA

PATENTS ACT 1990

PATENT REQUEST: STANDARD PATENT

I/We, the Applicant(s)/Nominated Person(s) specified below, request I/We be granted a patent for the invention disclosed in the accompanying standard complete specification.

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[54] Invention Title:

Optical Transmission Method with PM/AM Conversion

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Details of Basic Application(s):

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Basic Applicant(s): Siemens Aktiengesellschaft

DATED this FIRST day of FEBRUARY 1995

Siemens Aktiengesellschaft

By: J. H. Ferguson

Registered Patent Attorney

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INSTR CODE: 61890

IRN: 293512

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SPRUSON & FERGUSON

Australia

Patents Act 1990

NOTICE OF ENTITLEMENT

I, John Gordon Hinde, of Spruson & Ferguson, St Martins Tower, 31 Market Street, Sydney, New South Wales 2000, Australia, being the patent attorney for the Applicant(s)/Nominated Person(s) in respect of an application entitled:

Optical Transmission Method with PM/AM Conversion

state the following:-

The Applicant(s)/Nominated Person(s) has/have entitlement from the actual inventor(s) as follows:-

The Applicant(s)/Nominated Person(s) is/are the assignee(s) of the actual inventor(s).

The Applicant(s)/Nominated Person(s) is/are the applicant(s) of the basic application(s) listed on the Patent Request. The basic application(s) listed on the Patent Request is/are the first application(s) made in a Convention Country in respect of the invention.

DATED thi First day of February 1995.

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Optical transmission method with PM/AM conversion

The invention relates to a method corresponding to the precharacterizing clause of Patent Claim 1.

In optical transmission technology, the requirement for transmission capacity has continuously increased. In order to be able to provide the desired transmission capacities, systems are being developed with data rates up into the Gbit/s range, which systems, in addition, are intended to have as large a path length as possible without pulse regeneration. In so doing, the group velocity dispersion of the glass fibres used as transmission medium can have a limiting effect on the transmission range. One possibility for increasing the dispersion-limited range is the use of special glass fibres having low values of their dispersion parameters in the wavelength range used for the transmission, for example, for the transmission at wavelengths around 1.5 µm, so-called dispersion-shifted glass fibres can be used. As an alternative, dispersion compensators can also be inserted into the light path.

One method of the type mentioned at the beginning is disclosed in "Electronics Letters", 18 February 1993; Vol. 29, No. 4, pages 402 to 404, "Unregenerated Optical Transmission at 10 Gbit/s via 204 km of Standard Singlemode Fibre Using a Directly Modulated Laser Diode" by B. Wedding and B. Franz. In this publication, one possibility is presented which, in contrast with conventional transmission with intensity modulation and direct detection, makes it possible to bridge greater path lengths via a dispersion-induced frequency modulation/amplitude modulation (AM/FM) conversion. In the known method, a frequency-modulated optical transmitter is used, in the subsequent transmission an FM/AM conversion is carried out by means of a standard single mode fibre (SSMF), the conversion being demodulated on the reception

side by a direct detection receiver having an electrical filter in the form of a low-pass filter or integrator connected downstream. By means of the known method, at a wavelength of 1.5 µm, a distance of 151 km could be bridged without an intermediate amplifier. However, in so doing, a frequency variation of 6.5 GHz was necessary on the transmission side, which was achieved via the direct modulation of an FSK laser. In this known prior art, problems are especially presented by the fact that, at the data rates in the Gbit/s range envisaged for the transmission, a very large frequency deviation of the FSK transmitter is necessary, which is at the limit of that which is at present achievable with FSK laser transmitters.

In the present invention, therefore, the object consists in finding a simple possibility for increasing the range in the case of dispersion-limited transmission, which exceeds the limits existing at the present time for FSK laser transmitters at the data rate of the transmission signals.

According to the invention, the object is achieved by means of a method of the type mentioned at the beginning, which is developed by means of the features specified in the characterizing clause of Patent Claim 1.

Of particular advantage in the solution according to the invention is the small drive power needed for driving the phase modulator on the transmission side, in addition the cut-off frequency of commercially available suitable phase modulators is several times above that of FSK lasers with sufficient frequency modulation capability.

Expedient developments of the method according to the invention are described in Patent Claims 2 to 4. The invention will be explained in more detail in the following text, using an exemplary embodiment represented in the drawing, in which:

Figure 1 shows the curve of the phase modulator drive voltage in the case of driving with an NRZ data sequence,

Figure 2 shows the electrical reception signal after a transmission path of 150 km and

Figure 3 shows the demodulated binary data signal at the output of the decision circuit in the receiver.

The curve of the phase modulator drive voltage shown in Figure 1 resulted in the case of a data signal in the NRZ format and at a bit rate of 10 Gbit/s, the representation being carried out over a time of 3200 ps. The phase deviation generated optically on the transmission side is in this case only about 0.2 πrad, with the result that only a small drive power is necessary for the phase modulator.

In Figure 2 there is shown the electrical reception signal resulting on the reception side in the case of a signal curve corresponding to Figure 1, before the decision circuit, after transmission over a path of 150 km via a standard single mode fibre (SSMF). The fibre path had in this case a dispersion of 17 ps/(nm km). In Figure 2, at a relative amplitude of 0.9 and 1.1, the decision thresholds E set on the reception side are marked. In this case, it is noticeable in the signal curve according to Figure 2 that, in spite of the long transmission path, a trouble-free detection is possible on the reception side. In contrast, a signal transmitted by means of intensity modulation and direct detection would be no longer capable of evaluation, because of the distortions caused by the group velocity dispersion.

The pulse diagram shown in Figure 3 shows the demodulated binary data signal at the output of the decision circuit, which has an input subject to hysteresis. The comparison of the pulse diagrams of Figures 1 and 3 shows the correct transmission of a digital signal at a data rate of 10 Gbit/s over a fibre path of 150 km, the curves show that considerable system reserves are still available.

~~Patent Claims~~

The claims defining the invention are as follows:

1. Method for optical signal transmission with a range limited by the group velocity dispersion of the glass fibre used for the transmission, characterized in that, on the transmission side, a phase-modulated optical signal is generated with the information to be transmitted, which signal is emitted to a glass-fibre transmission path and experiences an amplitude modulation along this transmission path because of its group velocity dispersion, and in that, on the reception side, the transmission signal is detected with respect to its amplitude modulation.

2. Method according to Claim 1, characterized in that, on the reception side, a direct detection of the amplitude-modulated reception signal is provided.

3. Method according to Claim 1, characterized in that, on the transmission side, the transmission signal is generated by means of phase modulation with a phase deviation of a few tenths πrad.

4. Method according to Claim 1, characterized in that a standard single mode fibre (SSMF) is used as glass fibre.

DATED this FIRST day of FEBRUARY 1995
Siemens Aktiengesellschaft

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Abstract

Optical transmission method with PM/AM conversion

Optical transmission systems having data rates in the Gbit/s range are intended to have a large path length without pulse regeneration and intermediate amplification, with a view to the smallest possible expenditure. In this case, the chromatic dispersion of the glass fibre used can have a limiting effect on the transmission range. According to the invention, it is proposed for the optical signal transmission to transmit phase-modulated optical light on the transmission side, which experiences an amplitude modulation along the glass fibre transmission path because of its chromatic dispersion, and to detect the transmission signal on the reception side with respect to its amplitude modulation.

Fig. 2

134-12/95

FIG 1

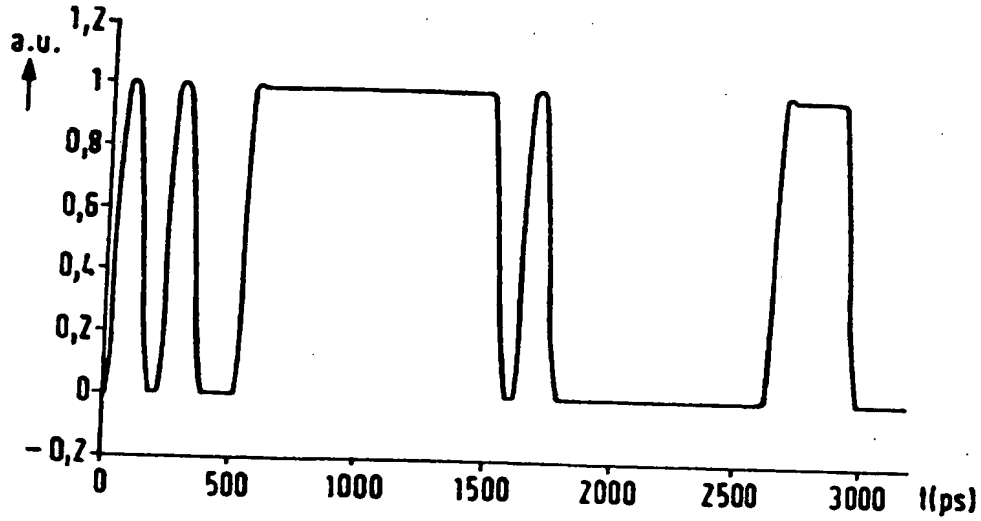

FIG 2

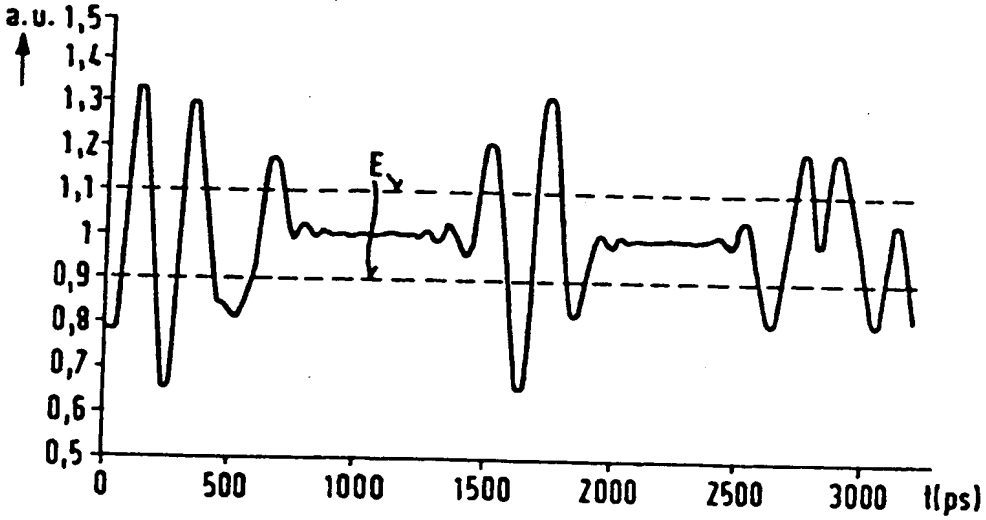

FIG 3